

CLAIMS

1. A nitride semiconductor device comprising:

a dissimilar substrate having a first major surface off-angled from a second major surface of said dissimilar substrate;

a nitride semiconductor layer selectively grown on the major surface of the dissimilar substrate in substantially a lateral direction, and

an active layer comprising a nitride semiconductor containing indium, on said nitride semiconductor layer.

2. A nitride semiconductor device according to claim 1, wherein the dissimilar substrate is one selected from the group consisting of sapphire having the C plane, the R plane, or the A plane as said second major surface, spinel, SiC, ZnS, GaAs, Si, ZnO, and $\text{La}_x\text{Sr}_{1-x}\text{Al}_y\text{Ta}_{1-y}\text{O}_3$.

3. A nitride semiconductor device according to claim 1, wherein said first major surface of the dissimilar substrate is off-angled stepwise.

4. A nitride semiconductor device according to claim 3, wherein the major surface off-angled stepwise comprises

terrace portions A and stepped portions B, wherein a surface of each terrace portion A is substantially parallel to said second major surface of said dissimilar substrate.

5. A nitride semiconductor device according to claim 4, wherein the terrace portions A are substantially regularly formed.

6. A nitride semiconductor device according to claim 4, wherein an average size of uneven portions on the surface of each terrace portion A is adjusted to about 0.5 angstroms.

7. A nitride semiconductor device according to claim 4, wherein a maximum size of uneven portions on the surface of each terrace portion A is adjusted to about 2 angstroms.

8. A nitride semiconductor device according to claim 4, wherein a stepped size of each stepped portion B is 2-30 angstroms.

9. A nitride semiconductor device according to claim 3, wherein an off angle θ of the off-angled first major surface with respect to the C plane of said dissimilar substrate is 1° or less.

10. A nitride semiconductor device according to claim 3, wherein an off angle θ of the off-angled first major surface with respect to the C plane of said dissimilar substrate is 0.8° or less.

11. A nitride semiconductor device according to claim 3, wherein an off angle θ of the off-angled first major surface with respect to the C plane of said dissimilar substrate is 0.6° or less.

12. A nitride semiconductor device according to claim 1, wherein the nitride semiconductor device is a light-emitting diode or laser diode device.

13. A nitride semiconductor device according to claim 1, wherein said nitride semiconductor layer selectively grown on the major surface of the dissimilar substrate includes laterally adjacent areas of higher and lower numbers of crystal defects.

14. A nitride semiconductor device comprising:

a nitride semiconductor substrate having a first surface and second surface;

a nitride semiconductor structure having an indium-containing active layer, the nitride semiconductor structure having been grown on the first surface of the nitride semiconductor substrate; and

an n-side electrode formed on the second surface of the nitride semiconductor substrate.

15. A nitride semiconductor device according to claim 14 further comprising a buffer layer in contact with the nitride semiconductor substrate, the buffer layer being a distorted superlattice structure formed by alternately stacking first and second nitride semiconductor layers having different compositions.

16. A nitride semiconductor device according to claim 15 wherein the buffer layer is operable as an n-side cladding layer serving as a carrier confining layer.

17. A nitride semiconductor device according to claim 16 wherein the n-side cladding layer is formed by alternately stacking an aluminum-containing nitride semiconductor doped with an n-type impurity and undoped GaN layers.

18. A nitride semiconductor device according to claim 14 wherein the nitride semiconductor substrate is doped with an n-type impurity.

19. A nitride semiconductor device according to claim 14 wherein the n-side electrode is made of a metal selected from the group consisting of Al, Ti, W, Cu, Zn, Sn, In, a multilayer thereof, and an alloy thereof.

20. A nitride semiconductor device according to claim 14 wherein the n-side electrode is formed on substantially the entire second surface of the nitride semiconductor substrate.

21. A nitride semiconductor device according to claim 14, wherein the nitride semiconductor device is a light-emitting diode or laser diode device having the n-side electrode provided on the back surface of the nitride semiconductor substrate.

22. A nitride semiconductor device according to claim 14, wherein a n-side electrode having a two-layer structure made of Ti/Al is formed on the nitride semiconductor substrate.

23. A nitride semiconductor device according to claim 14, wherein the number of crystal defects in nitride semiconductor substrate is less than $1 \times 10^5/\text{cm}^2$.

24. A nitride semiconductor device according to claim 14, wherein the nitride semiconductor substrate is grown by a halide vapor-phase epitaxial growth method.

25. A nitride semiconductor device according to claim 14, wherein the nitride semiconductor substrate is doped with an n-type impurity such that the n-type impurity concentration has a gradient, wherein the gradient from said first surface to said second surface is from lesser concentration to greater concentration.

26. A nitride semiconductor device according to claim 25, wherein the concentration gradient is continuous or stepwise.

27. A nitride semiconductor device according to claim 25, wherein the n-type impurity is one element selected from the group consisting of Si, Ge, Sn, and S.